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A MATHEMATICAL MODEL OF THE LOWER MEKONG BASIN

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A MATHEMATICAL MODEL OF THE LOWER MEKONG BASIN

by

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I. THE MEKONG : PRESENT AND FUTURE

The seventh longest river of the world which has obscure sources from the snows of the high Tibet plateau and flows for half of its 4,000 kms. length in a valley less than 100 kms. broad, when reaching the border of Laos expands in all its majestic importance; the low-water discharge which is less than 600 m^3/s at Luang Prabang and a little more than that at Vientiane, increases to about 1,000 with the apportion of the Mune, to 1,200 with that of the Sekong and surpasses 1,400 m^3/s south of Kratie and at Pnom Penh. There the drainage area is already 600,000 km^2, although it will add a further 100,000 km^2 with the apportion of the Tonle Sap, that "Grand lac" which acts so happily as a natural and beneficial reservoir moderating its floods. There also, the discharge becomes comparable to those of the largest Asian rivers; 11,000 m^3/s average, 39,000 at flood periods, the maximum estimated flood reaching 60,000 m^3/s.

Twenty million people live in its lower basin: two in Laos, seven in Thailand, five in Cambodia and six in Vietnam. The Mekong river is their father, everything comes from him: rice, maize and fish on which most of them live; in addition, it is their master road. But from it also come disasterous floods whose irregularity makes crops insufficient and uncertain and all life difficult.

What if the river might be regulated?

A dam at the Pamong gorges, 30 km above Vientiane, besides producing 400 MW of firm power would store 2 billion m^3/s and provide a water level higher than any other in North-eastern Thailand. A continuous discharge of 200 m^3/s for a period of four months would irrigate the dry Korat and Vientiane plains and permit navigation even during the dry period.

A dam at Khemarat 14 km upstream of the confluence with the Mune would store 5 billion m^3/s, in that way effectively moderating the flood discharge and increasing the low water level. A firm power of 1000 MW could also be generated.

At the falls of Khone a dam only 5 m high and a diverting channel would secure a drop of 30 m to generate 600 MW : there also navigation would become possible and vessels could proceed as far as Pakse.

At Sambor advantage could be taken of existing rapids upstream from Kratie for a dam to generate 500 MW and to irrigate 100,000 ha of fertile lands along both banks of the Mekong.

Finally a barrage on the Tonle Sap which connects the Mekong with the Great Lake would increase the latter's capacity as a flood reservoir and thus reduce the peak water level at Phom-Penh by more than 1 m, increase the low water discharge threefold, irrigate 150,000 ha of land, increase the rice production by 100,000 tons. But, we shall come back to this project later.

With these five works navigation would become possible all along the river with higher tonnage vessels; salt from the coast area of Vietnam where it can be produced as a small fraction of the production cost inland, could reach 10 million consumers without appreciably increasing its price; fish from the 'grand lac' could be distributed easily all over the country, thus increasing the advantage of fishing more and fostering the development of that activity which is essential in providing proteins to the whole region; timber from Laos where there are still 10 million hectars of virgin forest, could be transported downstream at tenfold or more the present rate, without the very high percentage of loss and pilferage now experienced.

Irrigation would increase enormously the cultivated areas and allow nobler and more valuable crops. Corn, cotton, tobacco would increase from their very low level production rates and rice itself could be obtained in better and higher priced qualities. To imagine the ratio of increase of production in terms of its value is something which has not even been attempted.

II. THE LOWER MEKONG COMMITTEE

To regulate the Mekong is a huge project; four different countries are interested in the lower part of the river, but none of them, nor for that matter all of them together, could have the technical resources, not to speak of the financial resources necessary for such a huge project. It is for this reason that the United Nations, through its Economic Commission for Asia and the Far East, have taken into hand its operation. The Mekong is an international river and it is only proper that the most international of all the organizations should meet the great challenge : the importance of the task is worth the tremendous effort involved. Projects have begun to be studied as far back as 1953, but there have been so many studies on the Mekong that no single one can be hoped to produce any result. Only a joint effort can bring about a comprehensive master plan.

It is with this in view that the United Nations have helped the four riparian countries establish in 1957 a Committee for the Coordination of study in the Lower Mekong Basin, which is an extremely interesting organization whose success should be a lesson to many other parts of the world.

The Committee is an assembly gathering quite often, consisting of representatives of the four countries which by this means are themselves responsible for their actions and their future. Moreover, they are certainly more competent to solve all the problems other than purely technical ones than would be people from any other parts of the world. To this assembly a permanent organ has been provided by the United Nations: the Executive Agent, and to assist him, a three-member Consultative Committee. The Executive Agent and the Consultative Committee provide the technical and operational direction of the decisions taken by the assembly.

A number of smaller projects have been started: pilot projects - one in each of the four countries - but the main big projects, those connected with the construction of dams but by no means limited to it, with all the resulting annexes, are still in the study phase, and one of them, whose necessity has been felt vaguely and indistinctly by the populations themselves for centuries, has now come to a point of maturity such, that concrete action has been judged necessary. This is the Project of the Tonle Sap, which of all is perhaps the most promising whilst at the same time the most complicated.

III. THE TONLE SAP PROJECT

At the beginning of the rainy season, the affluents of the Great Lake increase their discharge while carrying important solid content (which sometimes even obstructs them) and the lake itself discharges quietly through the Tonle Sap into the Mekong, which carries low floods.

Then the flood of the main river arrives: it is an impressive wave which in some places reaches a height of 14 metres. When this flood reaches Pnom Penh, the Great Lake has not yet been filled, so that water reverts its course back from the Mekong into the lake for most of the rainy season. Only after the end of the rainy season, when the level of the Mekong has sufficiently decreased, does the Great Lake discharge into the river and this goes on for half the dry season.

This regulating activity of the Tonle Sap is very important. One appreciates it when comparing the total volume stored in the lake, i.e. 40 billion m^3/s with the total discharge of the river which is 400 billion m^3/s.

The low water discharge which we mentioned to be 1,400 m^3/s per second at Pnom Penh, increases again to 2,000 m^3/s after it, due to the natural discharge of the great lake and the regulating effect is even appreciable during the flood period.

The Tonle Sap Project consists of erecting a movable barrage in the Tonle Sap: the best place for its location is part of the problem, although it should not be far from Kompong Luong.

When, during the early part of the flood season the main river carries low floods, the Grand Lake could be kept at its lowest level by keeping the barrage closed, and preventing the river from entering it. Only after the Mekong had attained a prescribed level, would it be admitted into the lake by opening the barrage and this would result in a considerable cut-off of the flood peak. The lake itself would become much more effective as a reservoir and its accrued volume would increase the amount of fish. Towards the end of the flood period and during the whole of the dry season, intelligent operation of the barrage would release water with great benefit to irrigation and improvement of the navigation; it is estimated that the regulated discharge released from January to May would add more than 4,000 m^3/s per second to the low water discharge, more than twice the present low water discharge of the Mekong.

The Tonle Sap Project has been studied quite extensively. Bulletin No.12 of the Flood Control series has given particular attention to the evaluation of the decrease of the peak flood and to the increase of the low water discharge. The Jamme Report has given consideration to the irrigation problem and has estimated at 40 per cent the mere advantage of making possible the cultivation of better rice qualities. It has also shown how the increase in the low water discharge during the dry season would push towards the sea the borderline of saline water, so that irrigation would become possible in regions where no cultivation of any importance has hitherto existed. This report is all the more interesting in that it deals in detail with the operation of the barrage and there we find an important scope for the construction of a model.

Again, the importance of a model in determining the correct operation of the barrage has been examined in the report by Bourrières-Paulsen and finally the Committee of the Mekong decided for the construction of the model.

Unesco immediately offered its assistance for this study and sent a 3-men mission in 1962 to study the problem of a model, on the site.

Models are a well-established means of solving hydraulic problems. However, in this case, one should think that from Battanbang to the sea there are 500 km of flooded country over a width of 200 km. Slopes at low levels from Pnom Penh to the sea are in the order of 1 cm and it would be extremely difficult to reproduce on a model these very small slopes, due to the intervening phenomena of capillarity and distortion.

A possible hydraulic model would have probably required a surface of at least one hectar with levels precise to 1/10 mm. This and many other considerations have led the members of the Unesco mission to decide on a mathematical model.

After this, action proceeded at an extraordinary speed which goes to the credit of the Agencies to which the United Nations have given the various tasks.

Unesco's mission was completed in September 1960. The report was appraised and approved by the Committee, a request submitted by the four riparian countries to the United Nations Special Fund in the same year. The Special Fund experts worked out the financial budget and the Consultative Board recommended the approval of the project by February 1961. Finally, the Governing Council of the Special Fund approved it by May 1961 and entrusted Unesco with the implementation.

The Department of Natural Sciences of Unesco immediately started preparing a Plan of Operation for the whole project and at the same time the search for a suitable laboratory which could be entrusted with the construction of the model began. A panel of consultants was also appointed: three hydraulicists and two mathematicians serve on it, contributing experience of four different countries. Seventeen laboratories were invited to submit a tender. Thorough examination of their proposals has led to the selection of one of them, well-known all over the world for its previous work in the same field. Eventually, the Plan of Operation and the contracts were signed, exactly one year after the date of the decision of the Special Fund and the same month the project was put into operation with the arrival of the first experts on the site.

IV. UNESCO'S PROJECT

Although the most interesting thing may certainly be the way in which the United Nations have turned an international river into an effective testcase of international cooperation for the benefit of a far-distant region, it may be interesting to see also how the Project works.

Four phases are foreseen:

During the first phase, data will be collected both in Cambodia and Vietnam - records, maps, survey information will be reviewed and all useful information assembled and classified. This phase has by now been completed.

The second phase will consist of the preparation of a preliminary model, utilising all the data thus collected. With this model trial runs will be made to determine how accurately it reflects the natural phenomena; a certain adjustment will be possible for it in order to make it as accurate as possible. Its main purpose will be to see by how much the various parameters are important for its operation. It is for instance anticipated that changing the discharge of a certain tributary by an important amount may have a negligeable effect on the model and this will mean that the exact knowledge of that discharge is not important and the data on which this knowledge is based need not be checked. On the other hand, it is also foreseen that some data will be critical in the sense that their variation may considerably affect the model and this means that they must be known with sufficient accuracy to make the model really representative of reality.

The third phase will then be constituted by a measurement campaign to check all the data which have proved to be critical: discharges of some of the tributaries and at selected points of the river, levels in certain places of the Great Lake, rains, winds, evaporation, etc. This campaign of measurements will extend over a complete year and it is expected that it will be completed by the beginning of 1964.

Then will come the fourth phase consisting of the construction of the final model. The expected accuracy should make it possible to evaluate the water heights within the Delta plain with a precision of 10 cm and the rate of rise of the water with a precision of 1 cm per day at such places and times where they are considered to be of importance.

As soon as the model has proved to be faithful enough in its reproduction of the natural hydrography and other pertaining factors, its operation will begin as a permanent means to establish the advantages of erecting a barrage, where to locate it, how to operate it. It should be possible to determine the optimum methods of operation for the various conditions of flood and of low flow, considering all limiting factors such as the fisheries, navigation, irrigation, forestry, production of electric power. It should also be able to determine the magnitude of the hydraulic conditions which might cause damage should the barrage be incorrectly operated.

The model, to sum up, will become an invaluable tool to guide the comprehensive development of the whole Lower River Basin of the Mekong.

V. CONCLUSION

Will the Project be successful?

To answer this we should first point out that it is the first time in the world that such a study is carried out in so vast a region with so many intervening phenomena. The project has been carefully studied and it should succeed, or at least it will provide the best possible results that modern techniques supported by adequate means permit.

The riparian countries are confident and all their technical personnel spares no effort in helping the international personnel involved in the Project, and as for the United Nations Organization, it should not be forgotten that their motto could be "We believe".

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